

The Masses and Prevalence of Small Planets with K2 - Cycle 2

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Our team is searching for transiting planets orbiting FGK dwarf stars in K2 fields. The first of our two objectives is to measure variations in the occurrence rate of planets as a function of sky position, sampling different star formation environments and stellar densities. We will learn whether our detailed occurrence measurements from the prime Kepler Mission (Howard et al. 2012, Petigura et al. 2013, Sanchis-Ojeda et al. 2014) can be applied directly to the solar neighborhood. We already see differences between the populations of planets orbiting nearby stars and stars in the prime Kepler Field. For example, hot Jupiters are 2.5 times less abundant in the Kepler Field (Howard et al. 2012). We have to wonder if the occurrence of Earth-size planets in the Habitable Zone (Petigura et al. 2013) is similarly reduced relative to nearby stars. With this proposal we will measure the occurrence of detectable, short-period super-Earths and Neptune-size planets (~2-3 Earth-radii). Our second goal is to discover small planets suitable for high-precision Doppler spectroscopy with Keck-HIRES and other instruments. Measuring the planets' masses will significantly refine our knowledge of the variation of planet density, composition, and atmospheric extent with planet size. This Cycle 2 proposal for the C6 and C7 fields is part of our larger effort covering all K2 fields and is a merger of the Cycle 1 programs by A. Howard/E. Petigura and J. Winn/R. Sanchis-Ojeda.

We select stars from the provisional TESS Dwarf Star Catalog (TDC), which combines 2MASS, Tycho-2, UCAC4, and other catalogs. Giant stars were cleansed using reduced proper motion cuts. request approximately 5000 stars in a magnitude-limited sample with $K_p < 13$ and approximately 3000 stars with $K_p > 13$ but excellent planet detectability (mostly late G and K dwarfs). This Cycle 2 request for Campaigns 6 and 7 is similar to our previous K2 Guest Observer proposals in C0 (R. Sanchis-Ojeda - 3641/7758 selected), C1 (R. Sanchis-Ojeda - 3755/7000 selected), C2 (E. Petigura - 4115/5311 selected), C3 (E. Petigura; 3859/5875 selected), C4 (A. Howard - 5195 proposed; J. Winn - 16,700 proposed), C5 (A. Howard - 4471 proposed; J. Winn - 15,600 proposed) constitute the primary sample of the bright FGK dwarf stars observed by K2. Here we propose 9829 and 8079 stars for C6 and C7, respectively.

We are searching for transit signals in the K2 photometry using the well-vetted TERRA pipeline (Petigura & Marcy 2012, Petigura et al. 2013). We will compute the occurrence rates of small, close-in planets using injection-and-recovery tests to account for the sensitivity of TERRA and will report the field-to-field variability and overall rates of planet occurrence. Assuming a precision of 80 ppm over 6.5 hours, a 2 Earth-radii planet with $P = 20$ -day will be detectable at $SNR = 8$ during a single 75-day K2 campaign. Based on the prime mission occurrence statistics, we expect to find 3.1 planets of size 2-3 Earth-radii with $P < 20$ days per 1,000 stars observed. A sample of 5,000 stars is expected to yield ~15 planets of size 2-3 Earth-radii with orbital periods less than 20 days, providing an occurrence measurement with 25% fractional uncertainty. With 5,000 stars, we will be sensitive to factor-of-two variations in the occurrence rate of 2-3 Earth-radii planets at 4-sigma significance.

In addition, we will identify the planets most amenable to Doppler mass measurements and observe them using Keck-HIRES and other facilities. These mass measurements will focus on detectable small planets -- short-period super-Earths and Neptunes and ultrashort-period Earths. Our team demonstrated technical expertise in all of the above areas during the prime Kepler mission.

This proposal directly addresses two objectives from the prime Kepler mission: measuring planet occurrence rates and characterizing small planets with Doppler mass measurements.